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RISK MANAGEMENT WORKSHOP
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by

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THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A 0H3.

Frank Quinn
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Abstract

This paper includes a brief overview of the nature of risk management as well as the results of a workshop on the subject held in February 1985.

Suggestions are made in order to better define the structure of decision processes, the risk management policies and the federal/provincial roles in risk management and to improve the legitimacy of risk management decisions.

Résumé

Ce rapport présente un bref aperçu de ce qu'est la gestion des risques de même que les résultats d'un atelier de travail sur le sujet qui a eu lieu en février 1985.

Des suggestions visant à mieux définir les structures du processus décisionnel, les politiques de gestion des risques et le rôle des gouvernements provinciaux et fédéral dans ce domaine et à améliorer la ligitimité des décisions prises sont présentées.

INQUIRY ON FEDERAL WATER POLICY
RISK MANAGEMENT WORKSHOP

Carolyn T. Miller, Ph.D

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Carolyn T. Miller, Ph. D.

Summary

In 1984 the Minister of the Environment established a Commission under the chairmanship of Dr. Peter Pearse to explore and make recommendations on issues of water policy and management within federal jurisdiction. A workshop on risk management was convened as one element of the Inquiry.

The Commission invited the participants at the workshop to provide advice on:

- how decision-making processes should be structured when significant uncertainty exists;
- how policies to guide natural resource management should be adapted to cope with uncertainty;
- how federal and provincial roles could be united into a workable partnership;
- how public policies for risk management could be made more legitimate.

"Risk management" involves analysing the consequences of the various options for on-going or proposed human activities, and deciding on adjustments that are in the public interest. The term generally implies that the choice of a course of action is based on a structured analysis of risks and benefits, and the fairness of their distribution. In the approach adopted at the Workshop, not only scientific analysis but also more intuitive perceptions and judgements play essential roles in decision-making. Stakeholders, publics, expert advisors and authorities work in concert to decide upon and implement a course of action.

Decisions influencing the management of water resources are made in the context of a dynamic environment in which human activities and natural phenomena interact. Assessing and controlling the impact of the industrial age on the overall integrity of the environment is a formidable challenge — a challenge to the powers of reason. Mankind can observe, evaluate and begin to understand the biosphere. In the light of this understanding, human activities can be deliberately modified to promote sustainable economic and social development.

Three different reasoning processes could be isolated, each contributing a new dimension to the understanding of man/environment interactions. First, the scientific process employs iterative observation, deduction, induction and hypothetical prediction to gain understanding of the laws of nature, the condition of the biosphere and predictions for the future. The second process, the process of public/market choice, has a significant intuitive element. In this type of rationality, individuals or groups with interests in common muster whatever powers of persuasion they can in support of their interests. The preferences of dominant coalitions emerge as a set of value judgements.

The third reasoning process must place the interests of society as a whole above the interests of individuals or groups. These three kinds of reasoning together determine appropriate interventions.

A general framework for the analysis of decisions in the public interest has emerged simultaneously from several fields. It incorporates all three rationalities and deals with the following bodies of information:

- human needs and wants;
- the stakeholders, experts and authorities involved;
- the weights of influence of the players;
- intervention options (actions and incentives);
- predicted positive and negative consequences of options;
- perceptions of the value/importance of consequences;
- sensitivity of the consequences to uncertainty.

The discussions at the workshop generated the following conclusions:

Decision Processes

- The ingenuity needed to improve the quality of life arises from three reasoning processes: scientific assessment, public/market choice, and the political inference that places the interests of society above the interests of particular publics. Decision-making should draw upon all of these forms of reason.

- A clearly identified authority should be responsible and accountable for ensuring that decisions are made, implemented and evaluated. Procedures for appeal should be spelled out.

- The decision process should have the capacity to make judgements on urgent issues and take prompt action.

Risk Management Policies

- Policies to guide interventions in human activities should recognize the equal right of all Canadians to environmental quality, and recognize the need to maintain essential ecological processes and life support systems.

- When uncertainty is high, public policies for risk management should (1) define the "due process" for decision-making as well as (2) provide guidance for resolving specific cases.

- Both the guiding policies and individual risk management decisions should consider the consensus developed through consultation with stakeholders and expert advisors.

Improving the Legitimacy of Risk Management Decisions

- Institutional arrangements are needed to negotiate a consensus, at both scientific and public levels, on priorities for social action.

- Improved measures of the health of ecosystems are needed.

- Improved communications between governments, stakeholders, experts and the public are needed.

- Legitimate environmental stewardship will require a deep-rooted social commitment to sustainable development. This social commitment should be supported by improved methods of risk perception and the resolution of conflicting perceptions; educational programs to display the interactions between human activities and natural phenomena; and school curricula to develop better understanding of risk, uncertainty and probability.

- Trust and respect for public policies will require the greatest possible openness and the full display of the elements of decision-making.

Overall, risk management provides a useful tool for organizing and displaying the information involved in public policy decisions. The framework accomodates disparate value judgements with respect to the importance of changes in the various social, economic and environmental factors at risk. Predictions are made about both the consequences and legitimacy of management strategies, and finally, uncertainties can be converted into guidance for further consultation, research and intervention.

INQUIRY ON FEDERAL WATER POLICY
RISK MANAGEMENT WORKSHOP
REPORT

Carolyn T. Miller, PhD.

History

In 1984 the Minister of the Environment established a Commission under the chairmanship of Dr. Peter Pearse to explore and make recommendations on issues of water policy and management within federal jurisdiction. The resulting Inquiry included public hearings across the country, as well as a wide-ranging set of research projects and workshops.

At the Risk Management Workshop, held February 20-22, 1985 at Strathmere House, specialists in the areas of economic analysis, perception of public values, ecotoxicology, scientific risk assessment and government infrastructure met with members of the Commission to debate short background papers and exchange perspectives on problems of risk management.

Commissioner Pearse opened the Workshop with two premises. First, he observed that polices to guide the management of water resources must recognize risk, uncertainty and unforeseeable change. Second, he concluded from his experiences during the public hearings that any process which fails to clearly allocate responsibilities and depends entirely on cooperation and good will is unrealiable.

The Commission challenged the workshop with providing advice on:

- how decision-making processes should be structured when significant uncertainty exists;
- how policies to guide resource management should be adapted to cope with uncertainty;
- how federal and provincial roles could be united into a workable partnership;
- how public policies for risk management could be made more legitimate.

Background

"Risk Management", taken literally, means controlling the chances of bad consequences. In practice, the term generally implies that the management strategy is based on a structured analysis of risks and benefits and the fairness of their distribution. To some, however, the meaning is more restricted. They maintain that only objective, scientific analysis should be involved in public policy decisions. Perceptions, feelings and public opinions are left out. In the approach taken at the Workshop, all reasoning processes were considered to be not only admissible, but essential.

A risk manager, for example, might look into the question of diverting water from its natural lake system to help reduce drought somewhere else. The risk

management process would look into the future, and figure out what is likely to happen if 10% of the water is diverted, 1% is diverted or none is diverted. The benefits of diversion to the drought-stricken area would be balanced against the benefits being derived from leaving some, most or all of the water in its natural location. Similarly, the risks of diverting or not diverting would be predicted for both areas. The decisions as to what to do would represent a trade-off taking into account the consequences (good and bad), how likely those consequences are, and how to make the distribution of the risks and benefits reasonable and fair.

Such risk management decisions are never easy. Different people attach a different level of importance to such things as agricultural profits, recreation potential and uncertainty about the long-term stability of ecological systems. It may be virtually impossible to please everyone. Lakefront property owners would howl if they thought their scenic view might become a 5 metre zone of sludge and slime, as a result of water diversion.

Further, it is rarely possible to predict precisely what will happen since scientific understanding of complex ecosystems is just beginning to develop. Often the trade-off must grapple with the possibility of a very serious consequence without much knowledge of how likely that consequence is.

Feasibility must be considered. Is it technically possible to divert the water? Costs must be considered. How much would the technology, engineering, maintenance and manning of a water diversion system cost? Would the increased crop yield pay for it?

Market conditions have to be considered. Would there always be a buyer for the diverted water? Who would pay for the diversion system in non-drought years? How often does a drought occur?

Even when a careful analysis has been made, and the preferred course of action has been decided, there still remains the problem of getting people to behave the way the decision-maker thinks they should. If it is decided that no more than 1% of the water should be diverted, what incentives can be arranged to reduce the temptation to take 5% when the drought is at its worst and the price paid for water is high? What arrangements could be made to ensure that the operators of the diversion system are accountable not only to their shareholders but also to both the buyers and the community whose natural ecosystem is being drained? Finding workable incentives, to make all of the players want to accept and honour the decision is one of the major challenges to the ingenuity of risk managers.

At the heart of "risk management" is the decision analysis that draws on the knowledge developed through scientific, social and economic assessment, and then balances different perceptions of the importance of the likely consequences. This analysis helps the authorities to choose a course of action that is in the best interests of society as a whole. Risk management is the combination of analysis, judgement and behaviour modification needed to achieve political, social, economic and environmental goals in an efficient, effective and equitable manner.

Objectives

The Risk Management Workshop addressed the problems of deciding on interventions that are cost-effective, widely accepted, and fair. (See Annex 1.) It was not the purpose of the Workshop to resolve specific issues such as whether to divert water, or whether to reduce the release of chemicals into the environment.

It was not the purpose of this workshop to explore the "how to" of risk assessment. Risk assessment is the task of experts from a wide range of disciplines - chemistry, biology, ecology, mathematics, toxicology, epidemiology, economics, sociology. The best available analytical tools are used to predict the consequences of each possible course of action and estimate how likely those consequences are. Rather, the workshop debated ways to use the results of risk assessment to assist with two kinds of decisions: which problems to tackle first, and then, for the priorities, what to do about them.

The Risk Management approach to decision-making does not make the decision for you. What it does is provide a framework - a guide to the kinds of information, consultation and reasoning needed to support the decision.

A Framework for Risk Management

The field of normative economics has provided a general approach for the analysis of strategies for social intervention. The Workshop reviewed the elements of "multi-attribute utility theory" in the form of a hypothetical case study of the analysis of water management options. A description of the quantitative application of the approach is provided in Annex 2. A qualitative overview is presented here.

Information Needs

Although the terminology used may differ somewhat in different sectors, most risk management frameworks are based on the same kinds of information.

1. **The People**

   The decision analyst needs to know who the decision authorities are. Who has the power to make, implement and evaluate the decision? Who do you go to, to appeal? Who administers the decision process? Who are the experts capable of bringing the tools and knowledge of the appropriate natural and social sciences? Who are the stakeholders - the publics that stand to benefit (or suffer) from the consequences of the decision?

2. **Desired Results (Objectives)**

   The analyst needs to know what it is that people need and want. Generally, these desired results are expressed in terms of the social, economic and natural aspects of the environment that people would like to achieve. For example, a social aspect could involve the level of government intrusion into

human activities; an economic aspect could be the return on investment in a water diversion facility; and important aspects of the natural environment could include the stability and aesthetic quality of lakefront property, and the agricultural productivity of a geographic region.

3. Measures of Achievement

Once the objectives "at risk" and subject to change because of the decision have been identified, the next challenge is to find ways to measure (or predict) the degree of achievement that has been (or might be) attained. Level of government intrusion might be measured as hours spent by stakeholders interacting with government officials; return on investment could be measured as percent recovered per month; stability of lakefront could be measured as the probability of a water level of more than 1 foot below seasonal norms and aesthetic quality could be measured as a change in the number and type of plant species.

4. Intervention Options (Actions and Incentives)

Having identified a problem - a source of dissatisfaction - such as poor agricultural yield due to recurring drought in a certain area, the analyst needs to know what the options for addressing the problem are. Various water diversion techniques, local water management, a shift to drought-resistant crops, or use of fast-maturing varieties could all be considered. In fact, lining up the options is sometimes the most open-ended component of the risk management process. There may always be another possibility, or combination that you haven't thought about!

For toxic chemicals, the selection of feasible intervention options requires analysis, in consultation with technical experts, of every stage of the chemical life cycle. Opportunities to break the chain of cause and effect may occur during research and development, manufacture, registration, transport, use or waste disposal.

In addition to lining up the options for preventive action, it is necessary to consider the feasibility of persuading people to modify their behaviour. In the water diversion example, it may be that a shift in the choice of crops would be best in the long run. But people get set in their ways and resist change. The analyst needs to know what incentives could be arranged, and whether the farmers in question would be likely to make the shift. Some examples of the range of available incentives are:

- process: jawboning, mediation, committees, consultations, adjudications, etc.
- regulatory: approved voluntary abatement, negotiated orders, permits, approvals, regulations, orders and injunctions

- civil liability and insurance
- regulatory economics: compensation funds, cleanup funds, emission charges, disposal pricing, marketable pollution rights, raw material pricing, delays, bonds
- fiscal support: tax deductions, rebates, credits, exemptions, equity/debt financing, government contributions, forgiveable loans, government loans, guarantees or insurance
- economic support: labour assistance, R&D support, export promotion

5. Predicted Consequences

For each intervention option, the consequences (good and bad) for each of the direct stakeholders and other publics must be predicted, using the objectives and measures of achievement already discussed. Very few predictions can be made with certainty and consequences often have to be expressed in terms of both the nature of the effect and the probability that it will occur.

6. Weight of Evidence

Expert judgement and consensus are needed to assess how good the predictions really are. Quality assurance indicators for the overall strength of the case, and for the range in which best estimates fall should be displayed.

These six kinds of information provide the basis for risk assessment - estimating the likely consequences of intervention options. Social, economic, environmental and human factors are all involved, and coordinated effort by experts from a range of disciplines from engineering to psychology is required. By assembling this information the analyst can clearly display the risks and benefits, who it is that will enjoy or endure them, and how strong the scientific case really is.

Risk assessment is the result of scientific reasoning - objective, dispassionate estimation of consequences. But decision-making requires more than just knowing the facts. Value judgements are required. The decision-maker must have significant understanding of how people perceive the importance of the various objectives.

7. Perceived Significance of the Consequences

Different stakeholders will perceive the importance of the objectives differently. To farmers, a water-shortage means disaster and the aesthetics of the lakefront seems relatively unimportant. To others, the reverse may be true. It is not a question of proving who is right or wrong. Each is entitled to his considered opinion. Such individual value judgements are reached intuitively. These in turn are subjected to debate and modification as each

stakeholder uses the powers of persuasion to influence others, until, by this ongoing process of "public choice" a consensus is reached.

Formal, quantitative application of multi-attribute utility theory assumes that measures of the consequences can be "scaled" - placed in order of increasing degree of significance. For example, for threats to long-term stability of a lakefront ecosystem, a score of 100 could be assigned if no threat was perceived. Zero could be assigned for substantial irreversible changes in 50% of the lakefront in regions with over 150 persons per square kilometer. Intermediate scores would be assigned to lesser degrees of damage. Clearly the valuation criteria are of paramount importance! A significant consensus-building process would be required to arrive at an acceptable "scale".

Further, quantitative application of the theory assumes that the scale of consequences for one factor (eg. ecosystem stability) is comparable to the scale for another (eg. health). That is, a score of "75" on both scales would mean that people would have great difficulty in choosing between them. These two consequences would be regarded as equally acceptable.

When the different consequences can be expressed in the same units - dollars for example - comparisons are fairly straightforward. The costs of a water diversion facility can be compared to the profits from agricultral productivity. But environmental results such as shifts in the type and number of species resulting from a change in water level are often uncertain, and far removed into the future. Studies show that people tend to discount future events heavily. On the other hand, uncertainty often leads to heightened levels of concern. Despite these problems people do make risk/benefit judgements all the time. "Should we go swimming on this beautiful beach even though the lifeguard has gone home?"

Even more difficult are quantitative procedures for comparing different objectives such as convenience or profit versus health. If using a pesticide runs a 10% chance of doubling the forest yield over 10 years, what risk should we take in terms of years of life lost or reduced health status for exposed people? For all the difficulty of making such judgements, people do make them. "Should I squeeze through this yellow light, or wait another cycle of the traffic signals?" For decisions with widespread social impact, a consensus on the relative importance of competing consequences is needed. This requires the participation of the direct stakeholders and other publics involved. The sociological tools for resolving different public perceptions have just begun to develop (see Annex 3).

8. Weight of Each Stakeholder

The decision analyst should attempt to find out how strong an influence each stakeholder is likely to have on the choice of activities, in the absence of any intervention by the authorities. This may be a very complex question, but it will shed a lot of light on how popular and widely accepted the management decision will be. In the end, the decision authority will have to make a judgement about whether the spontaneous influence of particular stakeholders

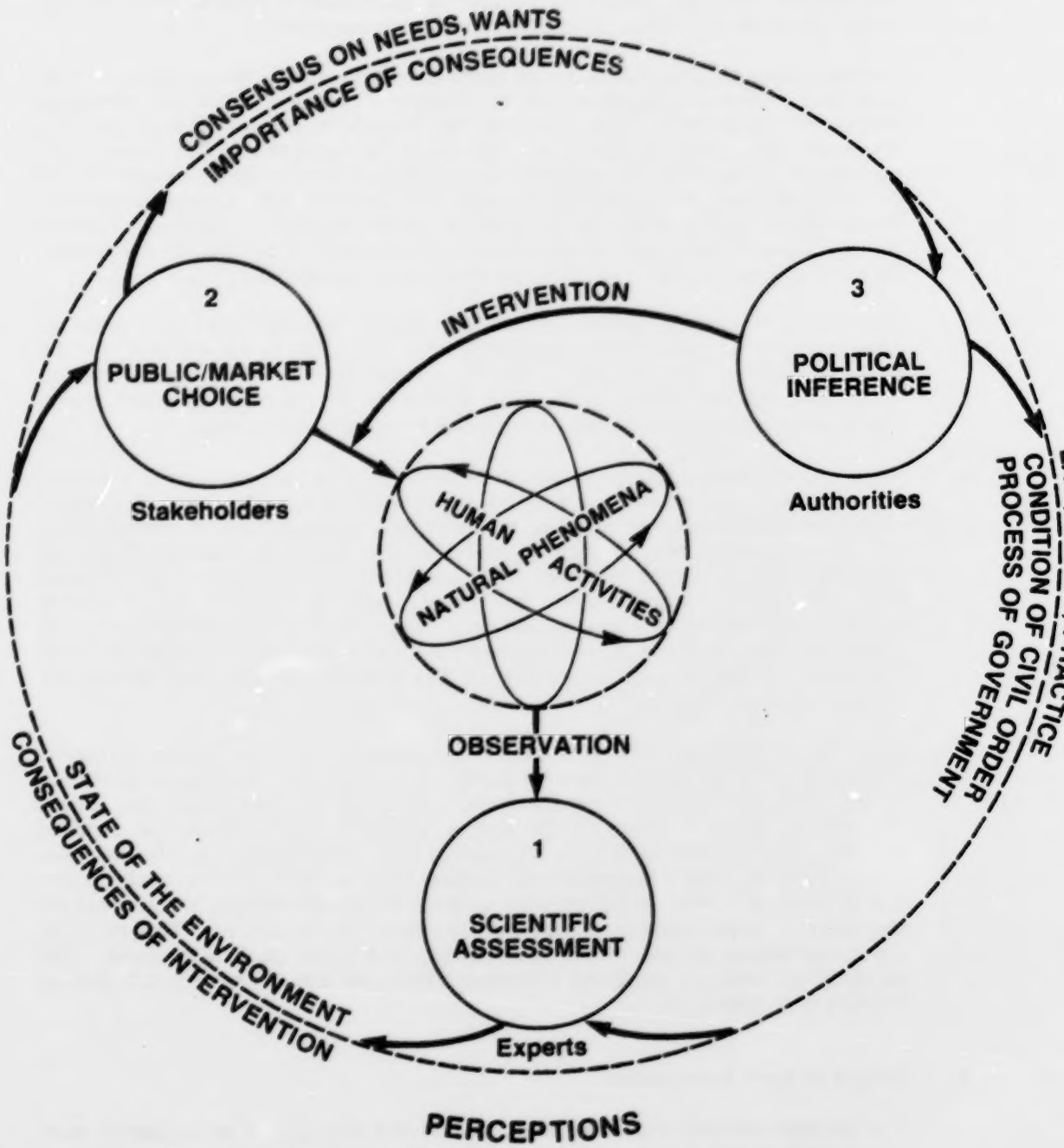


FIGURE 1 THREE RATIONALITIES: PARTNERS IN DECISION-MAKING

is what it ought to be. If not, then some form of intervention may have to be taken on behalf of society.

One way to adjust the weight that stakeholders have is to alter the membership of advisory groups. The access that a stakeholder has to the decision authority may determine the degree of influence.

9. Ethical Principles

In the final analysis, the decision authority must shoulder the burden of responsibility for deciding what is just. In making this political inference, ethical principles embodied in law, policy, practice and precedent will provide guidance. But in the end, the decision-maker (or each member of the "jury" if the decision authority is a group) must face the lonely challenge: "Make up your mind".

This body of information provides the basis for the risk management approach to decision-making. In figure 1, these elements are linked together by the intellectual processes that generate, communicate and use the information.

Three Human Rationalities: Partners in Decision Making (Figure 1)

Decisions influencing the management of water resources are made in the context of a dynamic environment. Human activities are changing; social customs, needs and wants are in a state of flux; and all of the physical, chemical and biological elements of the biosphere are influencing each other in a manner often too complex to comprehend. Nonetheless, for all its dynamic complexity, the biosphere has sustained an overall integrity throughout the geological history of life. Assessing and controlling the impact of the "new" human activities of our industrial age on this integrity is a formidable challenge.

As the impact of human activities becomes greater it becomes more and more important to have a valid perception of the nature of the biosphere and the role of mankind in it (see Annex 4). Three reasoning processes can be isolated, each contributing to human perception of the biosphere. The scientific method employs iterative observation, deduction, induction and hypothetical prediction to gain understanding of the laws of nature, the condition of the biosphere, and predictions for the future (See Annex 5 and 6). This objective scientific analysis is conducted mainly by specially trained experts. Unfortunately, scientists have a tendancy to communicate with each other rather than with the public at large. Often the "media" are called upon to function, not as a vehicle for transmission as the name implies, but as surrogate thinkers, and the message may get distorted. Scientists need to work harder at sharing their knowledge.

Within society, individuals or groups with interests in common engage in a different reasoning process, in which each public uses whatever powers of persuasion it can muster to gain support. This process of public/market choice has a significant intuitive element, and the preferences that emerge may not be consistent with the scientific assessment. However, this public choice rationality incorporates important judgements of the value of intangibles that are not readily amenable to current scientific analysis. It is encouraging that specialists in public perception and the more intuitive

processes for making value judgements are regaining a place for the social sciences in decision analysis. Without the insights derived from the social sciences public/market choices would remain a black box - something to be accepted without understanding. (See Annex 3).

While public choice and scientific analysis (natural and social) give rise to the aspirations and preferences of individuals or groups, a third rationality is required. "Political inference" must place the interests of society as a whole above the interests of particular publics. Politicians and bureaucrats generally have the greatest opportunity to apply this type of thinking. In our society specialists who have dedicated themselves to ethical philosophy (religious leaders, academic philosophers) generally must find ways to influence individuals, and through these individuals influence public choice. Our society often deliberately excludes ethical philosophers from any direct role in political decision-making!

Neither the bureaucrat, nor the elected representative, however, is a completely neutral broker. Officials are still people(!) and they will have their own consensus, determined at any point in time by the forces in their environment. Access to officials is therefore very important.

Whoever the decision makers are, their mental processes for political inference must gather in the perceptions resulting from scientific assessment and public/market choice and combine these with the standards of behaviour implicit in laws, policies, precedent and practice. The conclusions reached will determine the condition of civil order, the process of civil government, and the interventions imposed on public/market choice for the greater good of society.

If risk management is to be successful in assessing and controlling human activities so that essential ecological processes and life support systems are sustained, these three rationalities must be recognized and applied. The Risk Management approach accomodates all three of these reasoning processes.

Annex 4 describes "a widespread intellectual error in the conceptualization of the environment-society relationship". It proposes that many people in government, economics and public affairs conduct themselves as if the environment were "an element in the context of human affairs" - something to be exploited rather than nurtured. Yet, it proposes that these same people would probably claim to support the reverse perspective: "human affairs are an element in the context of the environent". — "When we look at the heavens and back at ourselves, we take our place --- within an encompassing environment".

Generally, participants did indeed support this second perspective. However, most also felt that the concept of management implicit in this document <u>is</u> one of nurture, and <u>is</u> consistent with "our situation as active participants in the biosphere". The reader is invited to make an independent judgement!

Roles in Risk Management (Figure 2)

Stage 1 - Consensus on Priorities

The first stage of decision-making for risk management involves consultation to identify problems and set priorities. This consultation may occur spontaneously as a result of interacting social or market forces and the sensitivity of politicians and bureaucrats to public pressures. Alternatively, the process may take place in a more structured way under the guidance of government. Whether spontaneous or deliberately structured, stakeholders and publics provide their perceptions of the condition they are and would like to be in, and scientists supply their estimation of the present and future condition of society/environment. Through consultation a consensus is reached as to which objectives are most important and which are not being met. Guidelines could be established to indicate what measurable level of environmental quality is desired.

Within government, line departments should be responsible for establishing communication avenues to draw in scientific (social and natural) assessments and public/market choices. If publics do not know that priorities are being negotiated, or do not know who to contact, or do not care enough to come forward, the range of participants may be biased, and the quality of all subsequent elements of the decision process will be jeopardized. The best system imaginable cannot do much if it is addressing the wrong problems.

Stage 2 - Decision Analysis

Once a consensus has been reached as to which social/environmental problems should be addressed, the decision analysis can proceed, using the classes of information and reasoning processes already discussed.

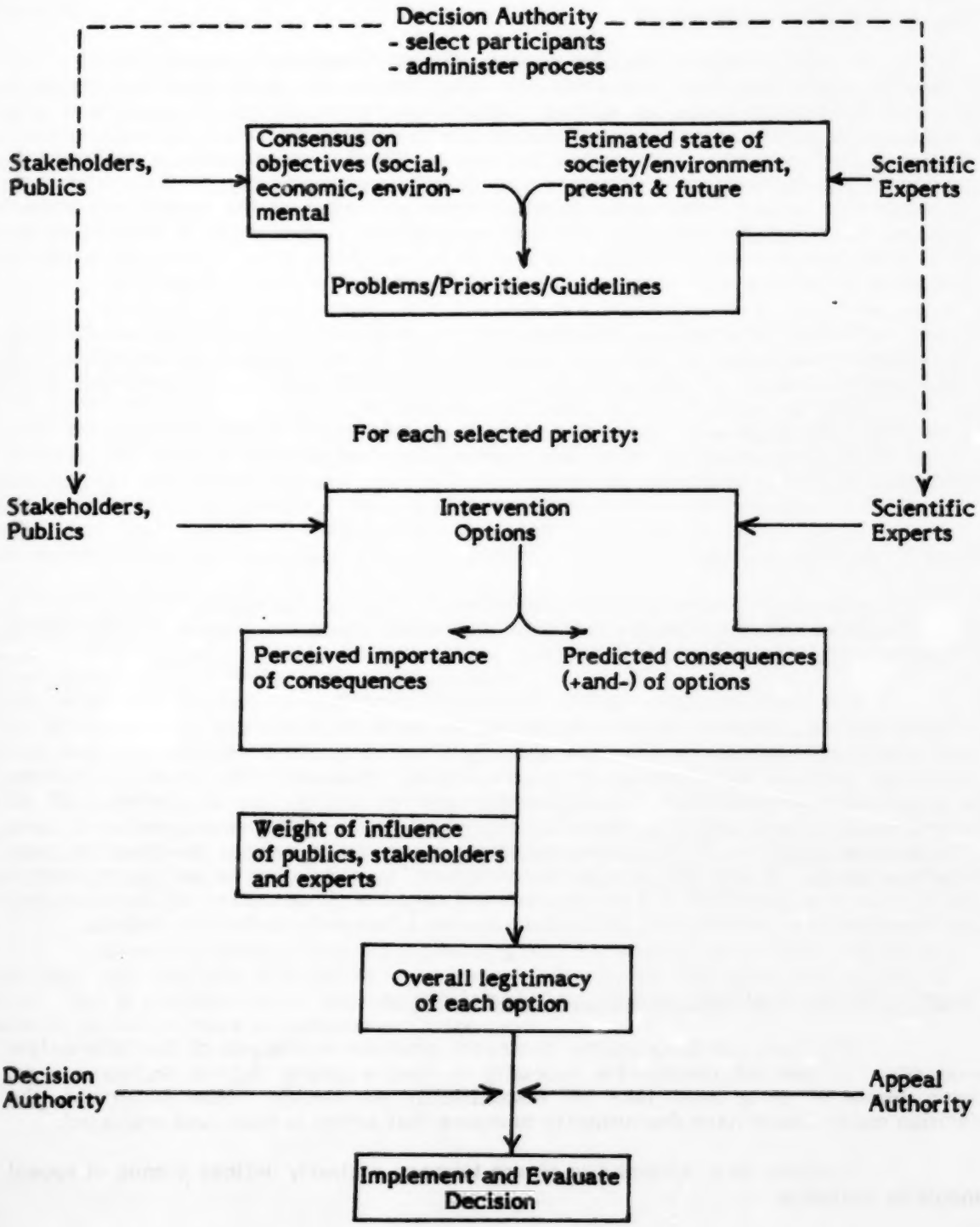
The multi-attribute utility framework describes a general procedure for decision analysis. However, by deletion of various elements it can easily be converted to more traditional approaches. For example, if all monetary attributes are combined into one number, and all non-monetary attributes similarly combined then the model reduces to cost-utility analysis like that frequently used in health care evaluation. If all consequences except one are valued in terms of dollars, the model becomes cost effectiveness analysis. If all consequences are given dollar values, the result is cost-benefit analysis. If only one option is considered (as in whether or not to register a specific use of a pesticide) and the positive and negative consequences (of pesticide use) are expressed in a common unit, the model becomes a "simple" risk/benefit analysis.

Stage 3 - Decide, Implement and Evaluate Social Action

The multi-attribute utility framework provides an analysis of the information available. It does not remove the necessity to have a clearly defined decision-maker. Some person or group must take the responsibility and decide. Most important, the decision maker should have the authority to ensure that action is taken and evaluated.

However, as a safeguard to ensure fairness, a clearly defined avenue of appeal should be available.

Figure 2: Roles in Risk Management



Uses of the Framework

This framework for the analysis of policy and intervention options does not make the decision for you. It can, however, contribute greatly to the efficiency, effectiveness and equity of the decision by displaying very clearly the players, the factors considered and the assumptions made.

The framework need not be used quantitatively. Indeed, participants at the Workshop felt that the quantification and scaling of estimates for environmental objectives is often beyond the capacity of current scientific techniques. However, qualitative assessments could be displayed in the same framework and achieve the needed clarity of analysis.

The multi-attribute utility framework has found three additional applications in practice. First, it has been constructively used as a consultative tool. The framework clearly identifies the dimensions of the decision: attributes at risk, constituencies participating, weights of influence, policy (intervention) options, predicted positive and negative consequences, perceptions of the importance of consequences and the sensitivity of the final outcome to uncertainty. By breaking the decision process down into these more manageable components, and building consensus on one element at a time, progress towards a legitimate solution is greatly facilitated.

Second, describing the decision process as a sequence of discrete steps provides the basis for sensitivity analysis. Steps where the range of uncertainty makes a critical difference to the final decision can be identified and researched further. In this manner the framework provides an objective approach to defining research needs and directing resources to the generation of the most crucial information.

Third, the intervention most likely to have the desired effect may be put in place first. After a delay sufficient to allow the intervention to take effect, re-assessment would then provide more accurate insight into the need for additional actions. Such step-wise management can be more efficient than attempting to solve all aspects of a complex problem at one time.

Overall the multi-attribute utility framework provides a useful tool for organizing and displaying the information involved in risk management. The framework accomodates disparate value judgements with respect to the importance of changes in the various social, economic and environmental factors at risk. Predictions are made about both the consequences and legitimacy of management strategies, and finally, uncertainties can be converted into guidance for further consultation, research and intervention.

Limitations of the Framework

The heavy demands for consultation, consensus-building and scientific prediction may be considered a drawback. In some situations much simpler analyses may suffice. However, when uncertainty is high science cannot substitute for consultation and the pooled wisdom of concerned constituencies. Further, if uncertainty is high, legal and regulatory approaches with specific punitive measures for defined behaviours are inappropriate. How can punishment be justified if the occurrence of the "crime" is uncertain?

This is not to suggest that regulation has no place in environmental management. A double-barreled approach can be effective. If an estimate of risk exceeds a critical level, regulations may be enforced. But within a lower range of possible risks, negotiation and consensus building could take over. (This approach has been used in Canada with respect to water & air quality objectives.)

Environmental quality guidelines may be used to trigger in-depth assessment and review. If meeting the guidelines imposes significant hardships, stakeholder negotiation and consensus-building could be used to find a legitimate solution. Broad national environmental legislation and policy is required to guide the resolution of disputes.

One limitation of consensus-building processes has been debated since the days of Plato. How can the integrity and objectivity of advisors be ensured, in the face of the oppoutunity to provide self-serving advice? If a toxicologist recommends a great deal more toxicological research, who is he serving? If industry recommends a solution that increases the immediate return on investment of shareholders, is the advice to be trusted? No absolute solution has emerged.

Openness of the decision-process and display of all the elements will make publics accountable in the eyes of their colleagues and peers. But if participating publics are selected on the basis of their social influence or the size of the "stake", the consensus that emerges is very likely to reinforce the status quo or even focus more sharply on the values of the powerful, without triggering negative peer pressure. More equitable solutions are likely to be found when community leaders, and publics who are not direct stakeholders have a strong voice in the consensus-building.

Consensus-building, like voting, is subject to deliberate "gaming" -misrepresentation to achieve winning coalitions. Playing upon human sensitivities and crowd appeal, or keeping information secret in order to cajole, embarrass or entrap people into a coalition is an old, and human, occupation. However, practitioners should be very cautious. Except for the very short term, openness and integrity have proven their worth!

Risk Management in the Canadian Setting

Scientific and Technical Input

The scientific approach involving iterative observation, induction and deduction, and hypothesis testing is commonly used as the starting point to estimate, understand and evaluate the conditon of society in the environment.

The scientific data base generally has two components, one resulting from "basic" studies of cause/effect relationships, and the second arising from specific studies designed to shed light on the particular problem at hand. However, some issues will be of immediate concern requiring urgent evaluation and action. Decisions will have to be made without the benefit of special research. The decision that the evidence is sufficient to warrant action is a political one with a significant intuitive component. This decision should remain the responsibility of elected representatives.

In any scientific analysis there are biases and uncertainties and the data should be presented in association with:

- the assumptions implicit in predictive models;
- sources and degrees of uncertainty.

It was considered imperative that scientific data be openly published to allow peer review and avoid the inevitable bias of closed communities. Time is required for dissemination, consultation and the resolution of different interpretations of the data sets. It might be efficient to establish a "science court" to formalize and accelerate the consensus-building process which contributes the scientific understanding needed to assist the resolution of a particular issue.

In many public policy decision processes, the scientific understanding becomes diluted and befogged as each layer of authority adds a new (intuitive) perspective. Scientists, perhaps because of their highly formalized rationality, find it difficult to communicate with publics and officials, and their particular insights and perspectives often either do not become a part of the overall decision at all, or reach the public after additional rounds of re-packaging by officials or the media. There is a real need to improve the public communication of science. The scientific community needs to lead itself out of isolation.

The Associate Committees of the National Research Council have attempted to provide a forum for the scientific input to priority setting. As a Crown Corporation, NRC operates at arm's length from the sectoral interests of any particular federal department. It had gained the confidence and respect of the scientific community and had both the in-house expertise and the external network to function effectively. These Committees were supported by a secretariat and a contract fund to establish scientific criteria for environmental quality. Unfortunately, this fund, along with its special secretariat have been cut. Workshop participants strongly recommend that the scientific consensus - building function be strengthened, and that much improved communications be developed with the line departments responsible for implementing interventions.

Values, Perception and Communication

The general framework for risk management (Figure 2) calls for the inclusion of risk perception whereby publics intuitively estimate, understand and evaluate the condition of society in the environment. The workshop participants agreed that opportunity for publics to make such input should be regarded as a fundamental right, accompanied by full disclosure of information in so far as legally possible. While a range of modes for public input (hearings, questionnaires, conferences, private interviews) has been tested out, the need to develop new ways to reconcile conflicting perceptions was identified.

Grass roots development of a better understanding of risk and uncertainty through a range of educational programs and school curricula was advocated. It was agreed that "stewardship" can only become effective when there is a genuine environmental ethos involving trust and partnership between government and publics. As a first step it is important to ensure that procedures and points of most effective public input are clearly defined and understood.

It was recognized that public consultation is itself expensive and that public debate of uncertain risks will generate a further social cost in the form of anxiety.

However, the Workshop agreed that public participation was fully justified by the benefits of confidence, security and sound decision making.

Federal/Provincial Partnership

In Figure 3, one possible allocation of responsibilities is presented. This model suggests that the federal government should lead a program of consensus building with respect to social/environmental objectives. In addition the model burdens the federal government with developing broad national legislation and policy outlining the rights of Canadians to environmental quality, with monitoring and reporting on the state of the environment nationally, and with the preparation of more detailed guidelines setting out national environmental quality objectives and indicators of achievement. In all of these responsibilities, the federal government has final decision authority and provinces participate as stakeholders.

In this model, the provincial governments provide the operational arm of environmental stewardship. Provinces monitor and report on the state of the environment provincially and set priorities for taking action in the best interest of communities. Provinces manage the problem-solving stage, administer the process for decision analysis, have decision authority and administer relevent legislation. The federal government would provide an avenue for appeal of disputes between provinces, and disputes over the interpretation of national legislation, policy and guidelines. Any "public" would have the right to appeal through the federal government.

A number of participants at the workshop saw this division of responsibilities as turning over the federal role to the provinces, risking a loss of equity and the emergence of pollution havens.

As an alternative, it was proposed that both federal and provincial governments could retain operational responsibilities. Integrated management could be achieved using CCREM as a forum to negotiate agreements. A Water Commission composed of representatives of both levels of government, industry and selected public interest groups would provide advice to CCREM. However, by its very nature, integrated management provides no final authority, and decision-making can grind to a halt.

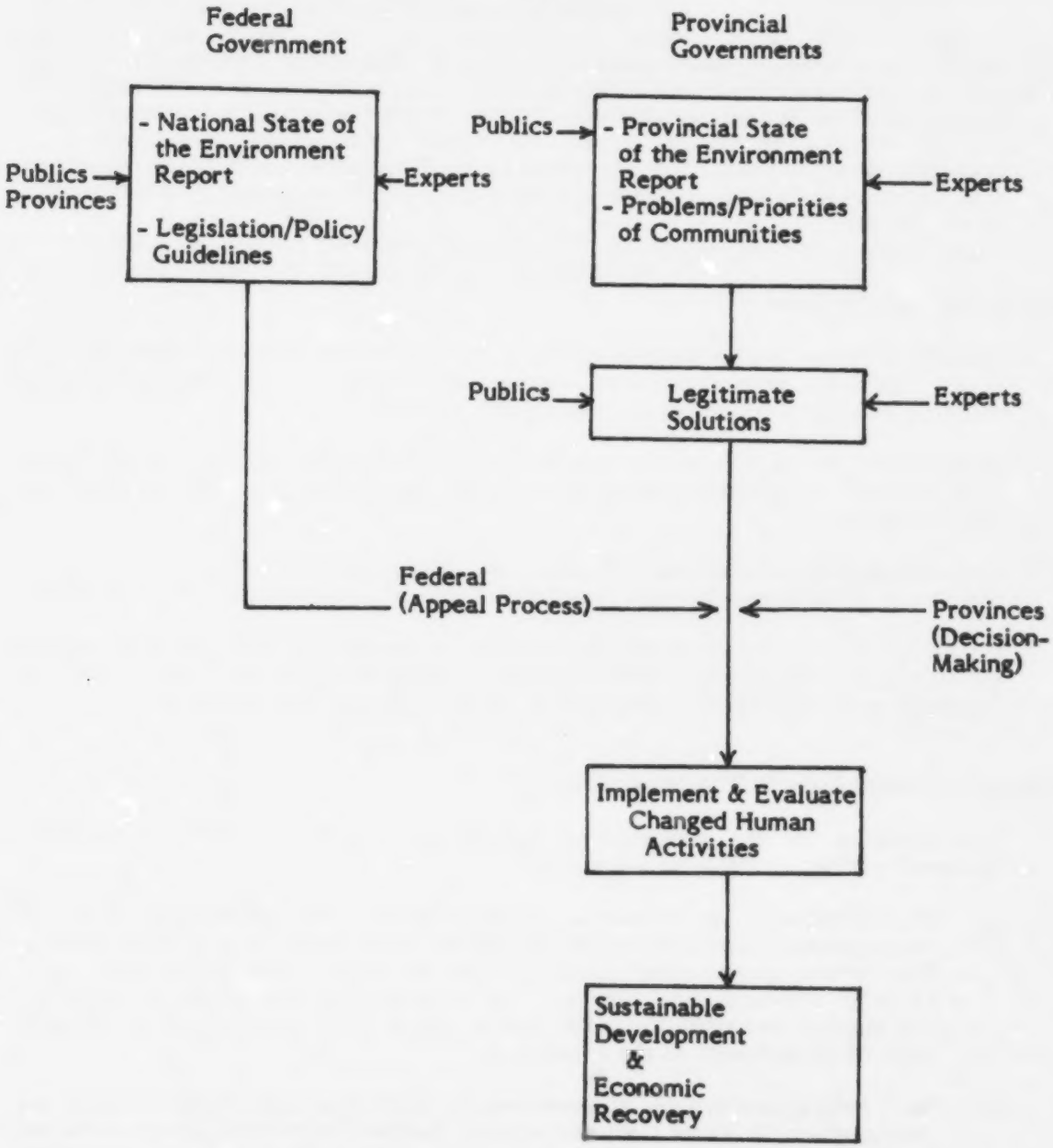
While participants were unanimous in supporting the need for national equity, with respect to environmental quality, they did not feel that the group had the expertise needed to reach a conclusion about the division of federal/provincial responsibilities.

Conclusions

Structure of Decision Processes

- In environmental decision-making uncertainty is the rule not the exception;
- The ingenuity needed to improve the quality of life arises from three reasoning processes: scientific assessment, public/market choice, and the political inference which places the interests of society above the interests of particular publics. Decision-making should draw upon all of these reasoning processes.

Figure 3: Federal/Provincial Partnership for Risk Management



- Three imperatives for responsible social action are recognized: a consensus on social values; cooperative analysis and prediction of the consequences of intervention; and effective procedures for adjusting human activities. Decision processes should include the institutional arrangements and access to expertise needed to satisfy these imperatives.

- Decision-making should include consideration of: the identity and weight of stakeholders; social, economic and environmental objectives; intervention options; predicted positive and negative consequences of options; public perceptions and the legitimacy of consequences, and the sensitivity of the final decision to uncertainty.

- A clearly identified authority should be responsible and accountable for ensuring that decisions are made, implemented and evaluated. Procedures for appeal should be spelled out.

Risk Management Policies

- Policies to guide interventions in human activities should recognize the equal right of all Canadians to environmental quality, and recognize the need to maintain essential ecological processes and life support systems.

- When uncertainty is high, public policies for risk management should (1) define the "due process" for decision-making as well as (2) provide guidance for resolving specific cases.

- Both the guiding policies and individual risk management decisions should consider the consensus developed through consultation with stakeholders and expert advisors.

- Individual decisions should serve the interests of communities and take both positive and negative consequences into account. However, such decisions should be consistent with national environmental legislation, policies and guidelines.

Federal/Provincial Roles in Risk Management

- Two scenarios for the allocation of federal and provincial responsibilities were discussed without choosing between them.

  (1) The provincial governments could become the operational arm of environmental stewardship and administer procedures for risk management. The federal government could function as arbiter of disputes and ensure national standards and equity. To achieve this separation of currently overlapping responsibilities, the federal government would have to delegate some of its authority to the Provinces.

  (2) Both federal and provincial governments could have operational roles in risk management. A Water Commission with members from both governments and appropriate publics would negotiate the distribution of responsibilities. However, unless all governments delegated their decision authority to the Commission there would be no accountable authority.

Improving the Legitimacy of Risk Management Decisions

- Institutional arrangements are needed to negotiate a consensus on priorities for social action. Improved measures of the health of ecosystems are needed. Perhaps most important is the need for improved communication between governments, stakeholders, experts and the public at large.

- Legitimate environmental stewardship will require a deep-rooted social commitment to sustainable development. This social commitment should be supported by improved methods or risk perception and the resolution of conflicting perceptions; educational programs to display the interactions between human activities and natural phenomena; and school curricula to develop better understanding of risk, uncertainty and probability.

- Trust and respect for public policies will require the greatest possible openness and the full display of the elements of decision-making.

Inquiry on Federal Water Policy
Risk Management Workshop

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Inquiry on Federal Water Policy
Risk Management Workshop

Annexes

1. "Issues and Questions for Discussion. Risk Management Workship, Inquiry on Federal Water Policy". Marcia A. Valiante, Director of Research, Canadian Environmental Law Research Foundation. 1985.

2. "Illustrative Exercise in Multi-Attribute Utility Theory Applied to Federal Water Policy. Mark S. Thompson, Harvard School of Public Health, 1985.

3. "Background Notes on Risk Perception". Anne Whyte. Man and the Biosphere Programme, UNESCO, Paris. 1985.

4. "Gaining Perspective on Environmental Issues: A Fresh Look at Familiar Problems". A personal account by Gail Stewart. From: Focus on Great Lakes Water Quality. Volume 10 Issue 1. International Joint Commission, United States and Canada, Great Lakes Regional Office, 1985.

5. "Discussion Topics: Retreat On/From Water Quality". Harold H. Harvey. Zoology Department, University of Toronto. 1985.

6. "Risk Assessment and Standard-Setting for Control of Chemical Hazards in Canadian Drinking Water". R. Stephen McColl, PhD, Department of Health Studies, University of Waterloo, 1985.

ANNEX 1

ISSUES AND QUESTIONS FOR DISCUSSION

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Canadian Environmental Law Research Foundation

La Fondation canadienne de recherche du droit de l'environnement

18 February 1985

Dr. Carolyn Miller
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Dear Dr. Miller:

As requested, I am sending a short paper of issues and questions for discussion at the Water Inquiry workshop on risk management. I hope the questions are helpful in showing you some of our concerns with this issue.

I look forward to meeting you and participating in the workshop.

Very truly yours,

Marcia Valiante

Marcia A. Valiante
Director of Research

Any consideration of the effects of water management options involves a consideration of the problem of risk and its management. Risk management is a term which has come to mean the quantification of risks associated with exposure to toxic chemicals ("risk assessment") and the determination of an "acceptable" level of risk from such exposure ("risk management").

Risk assessment is sometimes called the "scientific" part of the process and risk management the "political" part. It is important in any discussion of these issues to consider the degree to which these can be separated and their interrelationships.

The array of risks to which we are exposed raises the need to regulate in the face of a great deal of scientific uncertainty. This need, and some of the techniques of quantitative risk assessment being applied in the U.S. to address this need, raise a number of issues set out below which could be addressed by the workshop when discussing changing institutions to deal with these questions.

Obviously, in any regulatory decision such as standard setting for exposure to toxic chemicals, the most complete information available should be used. One of the most important problems with using quantitative risk assessment is the lack of data and the limitations of the methods used to gather data.

Given the limitations of these methods (such as reliance on single chemicals, emphasis on cancer, etc.) what kind of information should be required (for example, should there be both positive animal studies and epidemiological studies when regulating cancer risks) and to what degree should information be made public and tested through a peer review process?

In considering changes to the regulatory process, the question of who should participate becomes important, particularly when issues such as how conservative to be in estimating and controlling risks and what is an "acceptable" level of risk. Given the secrecy of existing processes such as that for setting national air quality objectives (where the objectives are set by government representatives whose recommendations and information leading thereto are not disclosed to the public), to what extent should the public (who must bear the risks of regulatory decisions, often disproportionately to the benefits accruing) have a right to participate in such decisions? How credible are regulatory decisions which exclude the public?

Given the large degree of uncertainty surrounding risk assessments, what is the appropriate role for risk assessment? Rather than enshrining a given level of risk as the basis for decision-making, is it more appropriate to use the methods as a way of setting priorities among a group of pollutants for further

assessment and regulation?

A further question is should regulators be trading lives and health off against the costs of pollution control or moving to eliminate risks to the extent possible?

Because of the interrelationships among all parts of the environment, is a multi-media (air, water, land) perspective on risk and control of risk necessary in order to manage risks to water quality from persistent toxic chemicals? How can regulation on this basis be accomplished?

The foregoing are some issues and questions of importance on risk assessment and risk management respecting water management. I look forward to discussing these and other issues at the Workshop.

ANNEX 2

ILLUSTRATIVE EXERCISE IN MULTI-ATTRIBUTE UTILITY THEORY APPLIED TO FEDERAL WATER POLICY

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Illustrative Exercise in
Multi-Attribute Utility Theory
Applied to
Federal Water Policy

North Gower, Ontario
February, 1985

Purpose of Exercise

All numbers in this example have been subjectively estimated by a non-expert in water policy and are arbitrary and debatable. They are intended to show how a possible application of the MAUT technique might proceed.

Policy Alternatives

1. Tough, specific, effluent standards for large industrial polluters.

2. Sale of pollution rights (by periodic auction) set to effect the same water quality level as in 1.

3. Effluent charges on all polluters leading to lower water quality than in 1. and 2.

4. Minimal regulation of pollution, encouragement of such adaptive measures as swimming pools and imported drinking water, and education of the public on precautions to reduce health hazards.

Constituencies and Their Weights

1. Major polluting industries (0.2)
2. Farms (0.1)
3. High environmental concern (0.2)
4. Others (0.5)

Attributes

1. Annual direct cost or gain to Government (100 = gain of $3 billion, 0 = cost of $3 billion).

2. Long-term effects on GNP (100 = 5 percent increase over continuation of status quo, 0 = 10 percent decrease).

3. Effects on industrial profits (100 = 10 percent increase, 0 = 10 percent decrease).

4. Effects on agricultural profits (100 = 10 percent increase, 0 = 20 percent decrease).

5. Level of governmental intrusiveness (100 = industrialists

and farmers not having to spend any time interacting with Government officials, 0 = farmers and industrialists having to spend 10 percent of their time interacting with and awaiting approvals from Government).

6. Water quality for outdoorspeople (100 = Canada in 1492; 40 = 20 percent of surface water being drinkable, 30 percent being swimmable but not drinkable, and 50 percent being unswimmable in regions with over 100 persons per square kilometer; 0 = no water of swimming quality in these regions, considerable travel required for camping and fishing in undespoiled areas).

7. Carcinogesis and teratogenesis (100 = 10 percent decrease in incidence from status quo, 0 = 20 percent increase).

8. Other water-borne morbidity (100 = 10 percent decrease, 0 = 20 percent increase).

9. Near-term disturbance of ecological systems (100 = no disturbance, 0 = reversible eutrophication of 80 percent of the surface water in regions with over 100 persons per square kilometer).

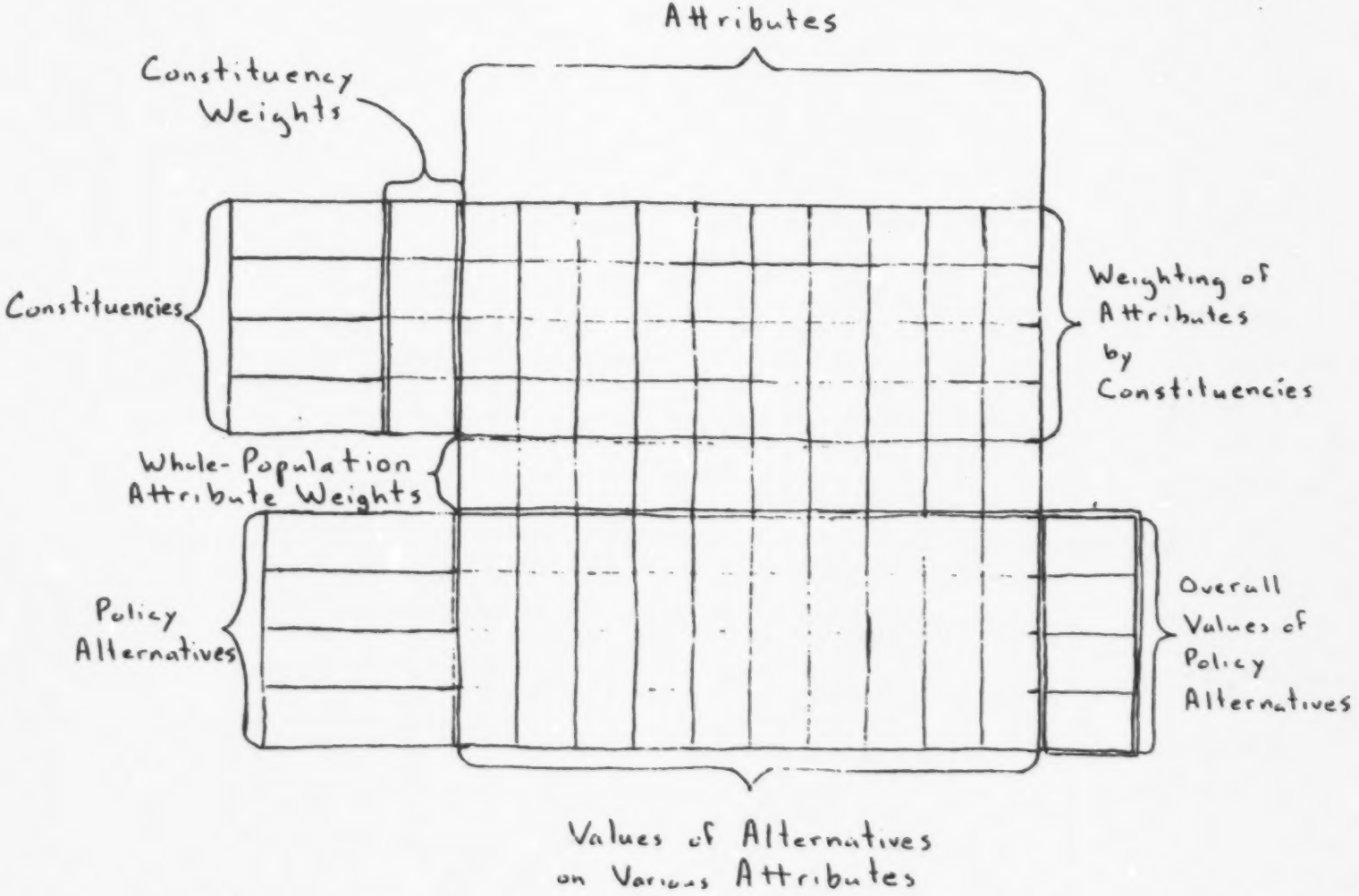
10. Threats to the long-term stability and existence of ecological systems (100 = no threat, 0 = substantial irreversible changes or destruction of ecological systems in 80 percent of the land and water area in regions with over 100 persons per square kilometer).

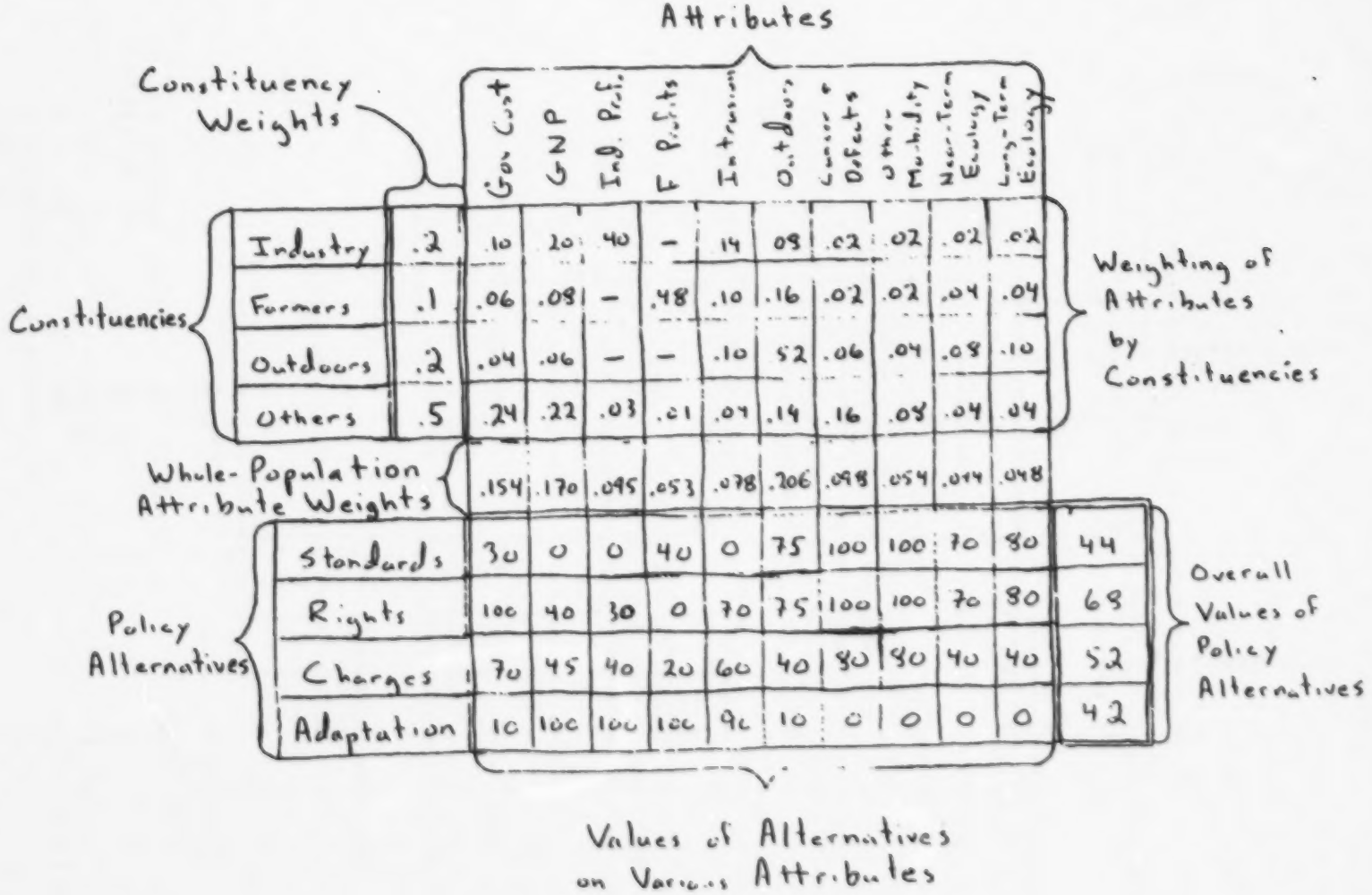
Illustrative calculation of first whole-population attribute weight:

$$(.2)(.10) + (.1)(.06) + (.2)(.04) + (.5)(.24) = .154 .$$

Illustrative calculation of first overall value of a policy alternative:

$$(.154)(30) + (.170)(0) + (.095)(0) + (.053)(40) + (.078)(0) + (.206)(75) + (.098)(100) + (.054)(100) + (.044)(70) + (.048)(80) = 44.31 .$$


Attributes
Constituency Weights
Constituencies
Weighting of Attributes by Constituencies
Whole-Population Attribute Weights
Policy Alternatives
Overall Values of Policy Alternatives
Values of Alternatives on Various Attributes


Attributes
Constituency Weights
Gov. Cost
GNP
Ind. Profits
Farm Profits
Intrusion
Outdoors
Consumer Effects
Other Mobility
Near-Term Ecology
Long-Term Ecology
Constituencies
Industry .2 .10 20 40 – 14 08 .02 .02 .02 .02
Farmers .1 .06 .08 – .48 .10 .16 .02 .02 .04 .04
Outdoors .2 .04 .06 – – .10 52 .06 .04 .08 .10
Others .5 .24 .22 .03 .01 .04 .14 .16 .08 .04 .04
Weighting of Attributes by Constituencies
Whole-Population Attribute Weights .154 .170 .095 .053 .078 .206 .098 .054 .014 .048
Policy Alternatives
Standards 30 0 0 40 0 75 100 100 70 80 44
Rights 100 40 30 0 70 75 100 100 70 80 68
Charges 70 45 40 20 60 40 80 80 40 40 52
Adaptation 10 100 100 100 90 10 0 0 0 0 42
Overall Values of Policy Alternatives
Values of Alternatives on Various Attributes

ANNEX 3

BACKGROUND NOTES ON RISK PERCEPTION

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BACKGROUND NOTES ON RISK PERCEPTION

Anne Whyte
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Unesco, Paris

O U T L I N E

1. Definitions
2. Risk perception compared to risk analysis
3. Psychological aspects
4. Sociological aspects
5. Characteristics of the hazard
6. Data limitations
7. Two major policy questions

1. DEFINITIONS

1.1 Risk perception

Risk perception is the process whereby risks are subjectively, or intuitively, estimated, understood, and evaluated. Although the term is often associated with lay people's assessment of risk, scientists and policy makers also estimate risks intuitively, especially when they are outside their own areas of expertise.

1.2 Public perception of risk

The public perception of risk is a concept, more useful to public policy than to science, which seeks to capture dominant views in society about particular risks. Since the main tool for estimating public perception is the social survey, the measure is almost always perception of a specified risk or class of risks (eg dam burst, dioxines in drinking water).

Risks have to become public policy issues before public perception of them is surveyed. By that time, information about the risk and/or related events, have reached the public through mass media. Inevitably, therefore, public risk perception, as measured, tends to reflect the way the issue has been addressed in the mass media, and is highly sensitive to hazard and media 'events'.

2. RISK PERCEPTION COMPARED TO RISK ANALYSIS

The simple physical model of risk used as the starting point in much risk analysis (Risk= probability x consequence) is inadequate for risk perception. The reasons include the following:

(a) there are limits and biases inherent in human information processing, which particularly affect the subjective estimation of probabilities;

(b) the usual measures of consequence (deaths, dollars lost, person-days of work lost) assume that people perceive all ways of death as equal, and all lives equal in value, which they are not; (cf. long painful death vs. quick heart attack; death vs. great physical incapacity; death of breadwinner vs. child or grandparent);

(c) it does not account for the fact that similar consequences which have different causes are perceived differently in terms of their public acceptability (cf. 'natural', Act of God, managerial incompetence, inequitable policy);

(d) it does not provide for the changing relationship between the probability and consequence expressions; as the conceivable consequences increase, the salience of probabilities deceases until in the case of the worse case scenario for catastrophic events, it reaches vanishing point; what is possible becomes more important than whether it is probable.

It is more useful to view these elements in risk perception, not as the idiosyncracies of the ignorant, but as challenges to the scientific and policy communities to improve their own measures of risk.

3. PSYCHOLOGICAL ASPECTS

3.1 Perception of probability

More attention has been given to the perception of probability than to the perception of consequences in risk perception research, particularly by psychologists, probably because perceived probabilities are more easily quantified and compared with mortality and morbidity statistics.

Experimental findings indicate that:

(a) people tend to underestimate the differences in probability between low and high frequency risks. In other words, the range of perceived probabilities is narrowed compared to statistical data; frequent causes of death

(cancers, heart disease) are underestimated and infrequent but dramatic causes of death (floods) are exaggerated.

(b) people tend to underestimate events that are stochastic in comparison to certain events (prospect theory);

(c) the 'errors' in subjective probabilities are due to certain limitations in human information processing. These include heuristic biases such as representativeness, (gambler's fallacy), availability, and anchoring; certainty and isolation effects;

3.2 Decision framing

For decisions made under uncertainty, the 'frame' of the decision (what is included, what is excluded) powerfully affects the choices arrived at. For example, non-users of seat belts were forced to frame their decision in terms of risk death per individual trip (1 in 3.5 million for USA) whereas users framed their decision in terms of the risk over their whole lifetime (1 in 1000). One of the most powerful roles of the mass media, and of risk education, is to influence the decision-frames of the public.

3.3 Perception of uncertainty

Several psychological responses are known to cope with the problem of uncertainty. These include:

(a) to perceive events as falling into a pattern. This gives the individual a sense of control over the environment in that he feels he can predict or expect when the next event will occur. It is a common phenomenon in the perception of floods.

(b) if people feel control, the level of risk that they find acceptable is generally higher (voluntary-involuntary dimension).

3.4 Perception of hazard cause

An important aspect of the psychology of risk perception for policy is the effect of attribution of causality. The scientific distinction between 'natural' and 'man-made' does not necessarily concide with perceived causes. Hazards such as floods are increasingly viewed by the North American public as man-made rather than Acts of God.

Experimental studies have shown that initial perceptions about cause and effect are remarkably resistant in the face of later, conflicting information.

3.5 Perception of benefit

It is axiomatic that people will accept higher risk if they are compensated with higher benefit. The question is one of decision-framing; what costs and benefits (and to whom) are included in the equation? Social surveys indicate that the public can make trade offs between, for example, economic growth and environmental protection. However, where health risks, such as drinking water quality, are concerned, the public view is usually to reduce risks even at the costs of also reducing benefits.

4. SOCIOLOGICAL ASPECTS

There is evidence of broad socio-economic and demographic differences in risk perception. These patterns are more consistent for the knowledge component of public perception (men, younger people, better educated usually have more information) than they are for the emotive, anxiety component (although generally, women and especially mothers with young children) express most concern about risks.

Regional differences across Canada are found for perception of certain risks reflecting differences in public policy agendas.

4.1 Role of information and mass media

A distinction needs to be drawn between direct and indirect information; wherever a hazard remains below human sensory perception, the role of information, especially mass media reports becomes magnified. Credibility in the source of the information affects how it is received, and this is particularly a problem for government. Although the public may recognise that journalistic accounts of events may be biased, they often feel that "there is something in them".

4.2 Expectations of government

The perceived problem agenda varies with the level at which the public feel responsibility for action lies. Thus health is seen as an individual problem whereas environmental quality is seen mainly as a community and provincial responsibility.

There is a mismatch between public espectations of the federal government's capability to solve major national problems and public evaluation of the way problems have been handled in the past. However, the Canadian public expects the government to protect them by regulating risk.

4.3 Historical dimension

In 1960, or even in 1970, the term 'risk assessment' was unknown to the general public in Canada, within 10-15 years, the public

has become aware of risks as a group of phenomena. They are more risk-conscious, and they believe that they are exposed to more risks today than in the past, especially chemical risks.

5. CHARACTERISTICS OF THE HAZARD

The characteristics of the risk; its magnitude, frequency, cause and impacts, interact with the psychological and sociological dimensions in risk perception. Thus the risk of flooding and the risk of chemicals in drinking water are both water related, but there the similarity for risk perception ends.

CHARACTERISTICS OF RISKS WHICH AFFECT PERCEPTION AND RESPONSE

Higher Salience	Lower Salience
High probability	Low probability
Recurrence interval within living or historical memory	Impacts not previously experienced/long time in past
Expected to occur soon	Longer time in future
Extreme event	Lower variability from norm
Imaginable/definable event	No clear beginning/end
High consequences	Lower consequences
Direct impact on people's welfare	Indirect effects
Loss of human life	No human lives lost
Identifiable victims	Statistical victims
Impacts grouped in space/time	Impacts random
Reasonably certain to occur	Uncertain/controversial
Effects/mechanisms understood	Effects/mechanisms not understood
Dramatic impacts	Less perceptible impacts

6. DATA LIMITATIONS

Data on risk perception have been obtained primarily through three methods:

a) laboratory experiments such as those conducted by social psychologists on heuristic biases;

b) field studies, such as those carried out by geographers on perception of natural hazards in tornado zones, floodplains etc;

c) social surveys, such as those conducted by sociologists and public pollsters on national samplers of the population.

Each of these methods brings with it various strengths and weaknesses, of which policy makers should be aware.

7. TWO MAJOR POLICY QUESTIONS

7.1 If public risk perception is to be included in risk assessment as public policy in a more formal way than it is at present, major questions are:

(a) how to measure public perceptions?

(b) how to reconcile conflicting perceptions?

(c) how to weigh public perceptions versus scientific, 'expert' opinion and other inputs to public policy;

7.2 Should risk assessment include the costs of perceived risk (ie. enxiety before the event; alienation from government and society)?

Some of these costs of perceived risk are theoretically measurable in dollar costs, such as reduced productivity through anxiety and increased government spending for public participation in policy making.

Even where dollar values cannot be assigned, there are social costs to risk perception which can be enumerated separately from economic accounting.

ANNEX 4

GAINING PERSPECTIVE ON ENVIRONMENTAL ISSUES

A FRESH LOOK AT FAMILIAR PROBLEMS

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FOCUS On Great Lakes Water Quality

Gaining Perspective on Environmental Issues: A Fresh Look at Familiar Problems

A Personal Account by Gail Stewart

The Environmental Challenge

I think the environmental challenge is recognized by all of us but it has been hard to know how to respond effectively. The incidence of environmental problems is widespread and some are of long standing, the risks are unknown but potentially very high, and action on specific issues is often in conflict with economic practice if not economic imperatives.

The situation I found, as I became interested in environmental issues and was invited into projects where people were addressing them, was almost invariably one of some agitation. Someone, usually a natural scientist, or occasionally a native person, was obviously concerned, and alleging that something was deeply wrong with the way we were thinking about environment. Others, including often other natural scientists or social scientists, were trying to respond but the responses were obviously not satisfactory and no dialogue resulted which was meaningful to both parties. It was clear that we had here a case of differing perceptions; that were apparently difficult to communicate, but I was unable to pinpoint the source of the difficulty or provide a bridging perception.

As I listened to people discussing the problems that they saw (and the work I was doing in the community and for Environment Canada provided an extraordinary occasion for talking with many people on the question of the relation between environment and economics) I was struck by the different meanings which people gave to the term environment. to some it was an all-encompassing reality, to others it was the great outdoors, and still others would distinguish natural systems from man-made environments. Others saw it in human value terms, as resources or amenities or unwanted goods such as pollution. And all of us referred to it differently on different occasions. Further, it was the subject of advocacy, intervention, regulation, moralizing, threat, management, charity and nurture in a bewildering array of policies.

Eventually I was able to make a distinction helpful to me (a distinction originally developed for use in other fields), and began to use it. Working as a member of the community with Environment Canada, I was able to demonstrate how the Department, by its manner of thinking at the corporate level if not in every program, had been taking one approach to the environment when it might have been taking another that would have been much more powerful and allowed it to pursue its mandate more effectively. In other projects too, I found that I could see more clearly how progress might be made. It become apparent that much of what we were doing with respect to environmental action was dealing with symptoms, and dealing in increasingly risky ways. It appeared to me faster, more effective, and more pleasant progress on environmental issues might be made if we were to address quite directly the core of the underlying problem, which was a

widespread intellectual error in the conceptualization of the environment-society relationship. The analogy that immediately came to mind was the field of health care, where fostering personal health and fitness may be faster, safer and more effective in the long run than continuing to fight sickness without attending in a prior way to health.

The Finding

The finding itself concerns a distinction in the point of departure that we use in the logical construction of our approach to environment, and it may be stated succinctly. For purposes of government, economics and public affairs generally, and in our daily lives, we have been approaching environment as an element in the context of human affairs. However, each of us if asked would probably say that in truth human affairs are an element in the context of the environment, and in this we would have the support of the natural sciences. From this perspective we must then be seen as making a fundamental error when we fail to take a priori account of the environmental context of our personal and social context.

The constructional logic itself is profoundly simple. Suppose, for the purposes of example, we take economic activity as the sort of human affairs with which we are concerned. Let economic activity be x, and the environment by y. Now consider whether, for practical purposes, y should in the first instance be considered a component of x or x be considered initially as component of y.

Most of us, it appears, hold in our minds and use both models. In one approach environment takes its place, along with other current issues, as presenting a set of problems we must address and act upon. In the other approach, familiar to geography students and in television documentaries on the earth and its history and available to us when we look at the heavens and then back at ourselves, we take our place, whatever else may characterize us, as elements within an encompassing environment. Both personal and public policy-making would be improved by the cross-substitution of x for y. This suggests that consciousness-raising and the practising of new perceptions would be a much preferable thrust for environmental policy than the extension of regulation in a context where the error remains in place. The former course leads towards the nurture of the environment, the latter towards the highly risky activity of global environmental management.

Each perspective is familiar as a starting point for thinking about environment. A sequence of decision-making that begins, however, by seeing environment as component of the economy, and for convenience deals with environment under the separate categories of resource issues, amenity and conservation issues, and pollution issues, (which is the typical way that environment is currently dealt with in economic and government and household decision-making processes in our society), actually creates risk: the risk that we will pursue management rather than nurture — that we will fail to see the forests for the forestry. (I have argued in another context, for example, that the creation of the new federal department of forestry is probably a good idea, provided that everybody understands that this does not relieve Environment Canada of its supervening responsibility for forests.)

Clearly, an approach which places environment as content rather than context for the economy is inferior in terms of both science and popular understanding to one which begins by acknowledging the ubiquitous and encompassing character of environment. An approach which addresses first the condition of our common estate and ourselves as part of it before turning to specific economic issues involving aspects of the environment seems clearly preferable. To proceed otherwise would now not only be identifiably irrational but would sustain and deepen present risk and invite ever-greater risk-taking.

The argument has immediate implications for the sequence of agenda items at meetings, for the directions of research, for the further development of public policy an corporate and government planning, for household operation, for environmental education, and for almost every other aspect of our affairs. It appears that we have known about our situation as active participants in the biosphere for many years but have not imported this knowledge into the logic of our public and private decision-making processes in consequence of the point of departure we have used for our contextual logic. With the appropriate first step in the contextual logic missing from our mental and symbolic models of the world; our environment has tended to remain invisible in our day-to-day decision-making and we keep forgetting where we are, at home in the thin skin of a spinning planet.

The communications problem between our agitated natural scientist (or native person) and the rest of us has persisted because, while we have both been talking about x and y and using the same works, we have not stated from the same implicit contextual relationship between x and y. It is a familiar problem in

inter-cultural communications, now applied to environment. A cross-substitution of contexts (for example, economics and environment) is the intellectual work that now calls us, with its associated process of language generation. (The activity would probably benefit from being given an appropriate name.)

Further, it seems clear that for our own safety if nothing else we must develop a global metaculture that, for initial puposes at least, sees x in the context of y. We need to practice talking about and seeing ourselves in environmental perspective. That will serve both the environment and possibly even a product of it.

The rare individuals in our society who against all odds have retained or developed that perspective may be able to help. For the most part, however, we are probably on our own in discerning its practical implications for our lives and customs. I personally think that informal consciousness-raising groups would be a good idea. The perspective, even when fleetingly grasped, is quite extraordinarily enlivening and plump with common sense or intuitive knowing. It immediately opens such "insurmountable opportunities" as could set off a new age at least as exciting as was the age of exploration when the world was discovered to be round rather than flat.

The challenge is intellectual and the enemy some of our present habits of thought. It is the kind of problem where remarkable progress can be made once it commands attention. I would leave you with the thought that it is an error in our contextual logic — an error in our manner of thinking about environment which is in turn having reflexive consequences — that is at the core of our environmental problems. By the same token, I believe that it is not so much moral exhortation and advocacy and regulation as it is intellectual work and new language development and information gathering from a new perspective that are now the priorities with respect to environment. What is needed is a new way of seeing our situation, based on a cross-substitution in our contextual reasoning.

Excerpts from notes for a talk delivered at a meeting in Ottawa September 25, 1984.

ANNEX 5

DISCUSSION TOPICS: RETREAT ON/FROM WATER QUALITY

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DISCUSSION TOPICS: "RETREAT ON/FROM WATER QUALITY"

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1. Loss of Diversity in Animal Life from Aquatic Environments

Surveys of streams, rivers, lakes, conducted at intervals show a trend in loss of species over time. For example, the eight streams tributary to the Niagara River (Canadian side, above the escarpment), such as Usher's Cr., typically contained about 25 species of fishes during the 1950's. The most recent surveys show only 5-6 species remaining. Similarly sampling sites in Burlington Bay show the number of fish species declining from 20-30 four decades ago to 4-5 currently.

Such loss of species has no single cause. The effects of many environmental perturbations are cumulative. The strategies currently in place for protecting the environment do not prevent this from happening.

2. Dumping of Unspecified Contaminants

The permit issued to the Hooker Chemical Co. 1975-80 allows for the dumping of up to 950 lbs/day of halogenated organics into Lake Ontario. The materials to be dumped are unspecified as to composition, toxicity, life expectancy, synegistic action, breakdown products, etc. The current permit is for 284 lbs/day.

Our current strategy for protecting the environment is based on the sequence: identification, toxicity, testing, establishing criteria, drafting regulations, monitoring emissions, seeking compliance, and court action. This strategy fails completely when the problem is unknown.

Do we need an alternative strategy? For example, dumping will be permitted only when the material to be dumped can be demonstrated to be harmless to the environment.

3. Substances too Toxic for Discharge in any Amount

The dioxin T.C.D.D. (2, 3, 7, 8 tetra chloro dibenzo dioxin) is one of the most toxic substances known to man. It bioaccumulates and renders fish unsafe for consumption in concentrations of p.p.t. It has been calculated that about 5 g discharged annually into Lake Michigan would suffice to put the fish from this lake out of compliance and thus destroy the fishery. This 5 g/year can be achieved from sources discharging below the level of detection.

The current strategy for protection requires monitoring at (reliably) detectable concentrations. Is the alternate strategy: (a) to ban the use of this chemical in the Great Lakes basin? (b) to ban its manufacture within the basin?

Should there be a list of chemical agents to be treated as per (a) and (b)?

4. The Precariousness of Domestic Water Supplies

The water quality objective for T.C.D.D. (2, 3, 7, 8 tetra chloro dibenzo dioxin) is put at 0.25 p.p. quadrillion in drinking water (U.S.E.P.A.) Lake

Ontario has a mass of 3.11×10^{15} kg. Thus about 1.5 lbs of T.C.D.D. are required to achieve a concentration of 0.25 p.p.q. The Hyde Park dumpsite, Niagara River drainage, contains a ton of dioxin.

The drinking water objective for lindane (hexa chloro cyclo hexane) is 20 p.p. trillion. A concentration of 1 p.p.t. would thus require 3 mt ton to be added to Lake Ontario. The Love Canal dumpsite contains 6,900 tons of hexa chloro cyclo hexanes.

These and other dumpsites along the Niagara River are leaking into the underlying limestone and thence into the river and Lake Ontario, at an unknown rate. Leakage of 0.1% to 1.0% of dumpsite contents into Lake Ontario would put it out of compliance.

There is no strategy in place to prevent this contamination of Lake Ontario.

What is the alternative strategy? Does Toronto, for example, build an aquaduct from Georgian Bay to Toronto to guarantee a supply of safe drinking water?

5. The Solution to Pollutions may not be Dilution

It has come to be accepted as a truism that, all substances are toxic to life at some high concentration, and the corollary is that all substances are harmless at some low concentration. This assumption needs to be challenged. For example, phosphorus has two radioisotopes (^{32}P and ^{33}P). Phosphorus is taken up quickly by cells and frequently is contained in the cell nucleus where the opportunity for damage through emissions is maximized. More importantly, phosphorus is taken up into DNA and RNA. The radionuclides of P break

down into sulfur, making nonsense of the genetic code. Thus, it is harmful in all concentrations.

There is a second family of substances for which discharge could be banned at any concentration. For example, Lake St. Mary was contaminated with mercury through large-scale losses of Hg from chlor-alkali plants, prior to 1971. The lake is still out of compliance, and larger fishes exceed the 0.5 p.p.m. Hg standard. Nonetheless Hg discharge of 1 lb per day is still permitted into the lake.

Alternate strategy: Can we ban the discharge of contaminants where the environment is already out of compliance?

6. The Catch-22

The case against acid rain is based on the loss of resource, but if the resource is lost, then protection becomes unnecessary. At the Sandefjord Conference, a spokesperson for CEGB commented to the Norwegian hosts that as 55% of the lakes in Southern Norway had lost their fishes, it was not worth the cost of reducing emissions to save the rest. Canadians may find themselves in a similar situation, in that the early evidence of acidification of the environment has not led to action to reduce emissions. Indeed, there are still no defined criteria for assessment of acidification. The criticisms of the current research approach, as included in the Canada-U.S. Memorandum of Intent, have not led to any operational directives to researchers.

Alternative strategies: (1) Continue to search for a U.S.-Canada accord. (2) Proceed independently to reduce emissions.

ANNEX 6

RISK ASSESSMENT AND STANDARD-SETTING FOR CONTROL OF CHEMICAL HAZARDS IN CANADIAN DRINKING WATER

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Risk Assessment and Standard-Setting for Control of Chemical Hazards in Canadian Drinking Water

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I. Fundamental Considerations:

Contamination of drinking water by toxic chemicals currently represents a pervasive environmental concern for many Canadians. Apprehension about the quality and safety of drinking water arises both from the scientific uncertainties in setting standards for water toxicants, and the public's perception of the health risks associated with these standards.

From the scientific viewpoint, the main considerations that are included for deriving drinking water safety standards are as follows:

1. Exposure:

Water is an essential component in the human environment. Since consumption is obligatory for the maintenance of life, exposure to water toxicants occurs continually throughout the entire lifespan of all individuals in the population. Exposure can also occur through contamination of water-based prepared foods and beverages and from biomagnification of water toxicants through the food chain.

2. Susceptibility:

Since exposure to water toxicants is unavoidable, hyper-susceptible members of the population (such as infants, the elderly, and those with special health problems) will be especially at risk for toxic effects from water contaminants. Individuals with unusually large amounts of water intake (e.g., workers in hot or strenuous occupations) may also be at increased risk.

3. Control Procedures:

As a homogeneous substance that is generally supplied from a single source (at least in urban areas), water toxicants are relatively easy to detect, monitor, and control compared to other modes of exposure such as air pollutants or food contaminants. Since water toxicants are especially amenable to control procedures, allowable levels of these toxicants should follow the ALARA principle (As Low As Reasonably Achieveable) to minimize health risk in the population.

4. Nature of Toxic Effects:

Three basic classes of water toxicants are each assessed and regulated in different ways. For inorganic toxicants (mainly metals), standards are frequently derived from occupational exposure standards or epidemiological studies on human populations. For organic toxicants, which are less well characterized in their chemical and toxicological properties, animal chronic toxicity studies are more frequently utilized to produce standards. For carcinogenic substances (usually organic) more specialized animal bioassay and extrapolation procedures are used to estimate carcinogenic risks.

5. Quality of data:

Where sufficient amounts of valid reliable toxicological data are available (especially direct human toxicity data), the size of safety factors used for setting acceptable exposure standards are relatively small. Conversely where data is incomplete, unreliable, or not directly related to human exposures (i.e., in experimental animals), larger safety factors must be incorporated to take into account the greater uncertainty in the formulated standard.

II. Regulation of Drinking Water:

Drinking water standards in Canada are delineated in Guidelines for Canadian Drinking Water Quality (1978). Since drinking water quality is a provincial responsibility, the federal standards are not legally enforceable, but serve as guidelines for provincial standard-setting. In almost all cases, the provincial regulations are identical to the federal guidelines, although some provinces have additional special standards for locally significant water contaminants.

The primary water standard in Canada is termed the MAC (Maximum Acceptable Concentration), defined as the maximum allowable concentration of contaminants not producing visible health effects or objectionable aesthetic properties (taste, odour, appearance). Although the MAC standard is defined as a "safe" level of exposure, the Canadian guidelines do acknowledge that much more stringent criteria are generally desirable to ensure the highest possible water quality. Two types of subsidiary standards are therefore specified: the objective concentration (OC) represents as "ultimate quality goal for both health and aesthetic purposes", while the target concentration is used to define acceptable limits for radionuclides which theoretically have no threshold of toxicity. Canadian drinking water standards are exceptional in a number of ways. The number of regulated substances, both inorganic and organic, are significantly more extensive than in many other countries, such as the United States. Likewise, the specification of dual level standards for maximum (MAC) and optimum (OC) toxicant concentrations is not reproduced in the American context. Sampling of water supplies is also more frequent.

In comparing the Canadian and U.S. MAC standards, there is a generally close agreement for most chemicals. This is not surprising considering that both sets of standards are based on similar or identical scientific data and criteria. However, in the case of certain putative organic carcinogens such as the trihalomethanes (THM's), the Canadian MAC standard is much more lenient (350 ppm) than the U.S. standard (100 ppm). These dissimilarities are based mainly on the differing scientific rationale governing the risk estimation for carcinogenic hazards.

In the Canadian rationale, THM's (mainly chloroform) are considered as "epigenetic" cardinogens, acting on a non-genetic process leading to cancer. Conversely, the U.S. criteria treat THM's as potential "genotoxic" carcinogens.

The main difference between these two mechanistic rationales is that there is a theoretical toxicological threshold for epigenetic carcinogens, so that small doses are not dangerous, while for genotoxic carcinogens there is no theoretical threshold. In the latter case, even minute exposure would lead to a small but significant risk of cancer so a more stringent standard must be applied. A similar mechanistic rationale allows for a MAC standard for nitrotriacetic acid (NTA) in Canada, whereas the substance is banned in the U.S.

III. Standard-Setting:

It is remarkable that many water quality standards are not derived from direct measures of water-related toxicity but rather from health effects in occupational settings or in experimental animals. One of the greatest obstacles to assessing risk for water toxicants is the inability to obtain reliable and unambiguous evidence of health effects from trace amounts of toxicants, especially organic toxicants. For example, numerous epidemiological studies (both ecological and case-control) have demonstrated a weak trend toward increased G.I. and G.U. cancers in populations exposed to THM's and other organic contaminants in water. However, the magnitude of the effect is slight (only about 2-fold excess risk), so that statistical unreliability and confounding variables obscure the significance of the data.

In the case of some inorganic toxicants, such as barium, a direct adaptation of the industrial TLV standard can be performed. In other cases, chronic animal studies are utilized to derive an "acceptable daily intake" (ADI) standard, such as for cadmium. Certain common environmental pollutants, such as lead and fluoride, can be assessed directly from clinical or epidemiologic evidence. For most inorganic toxicants the safety factors for drinking water are unusually small, about 2-4 fold below the generally accepted threshold of toxicity. The small margin of safety provided by these standards remains an ongoing source of concern.

For non-carcinogenic organic toxicants (including pesticides and herbicides), most standards are derived from chronic toxicity studies in animals. Generally the standard is derived by taking the NOEL (no observed effect level) value from animals (2 species) and dividing by a safety-factor (usually 100) to provide an adequate margin of safety. If there is only limited animal data, an addition factor of 5 or 10 is introduced to account for the uncertainty of the dose-response relationship. Therefore in many cases, the overall safety factor is 500 or 1000.

Finally, for carcinogenic substances, there is no commonly acceptable procedure for reliably estimating risk at low levels of exposure. Estimates of risk based on current statistical methods produce standards which are extremely stringent, so much so that they cannot be realistically applied using currently available technology.

IV. Recommendations:

1. Many drinking water contaminants have not yet been characterized either chemically or toxicologically. This problem is especially relevant to organic chemicals produced by toxic wastes, chemical discharges, or by chlorination reactions with organic constituents of water. Better detection and screening procedures need to be developed.

2. The primary standards for drinking water (MAC's) should be derived more directly from human epidemiological data or clinical data, rather than as indirect adaptations of occupational or air pollution standards.

3. The values assigned to safety factors in deriving MAC or ADI standards should be continually re-assessed. For inorganic toxicants, more stringent safety standards may be required. For non-carcinogenic organic toxicants, safety factors should be reduced as more reliable animal data becomes available.

4. For all types of toxicants, more attention should be focused on the mechanistic aspects of toxicant action, so that standards may be derived with a more fundamentally valid set of criteria. This is especially necessary in the case of suspect carcinogens, where different rationales may be applied for genotoxic and epigenetic carcinogens. This approach would produce more realistic and biologically relevant standards for drinking water carcinogens.

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